Renewable and Sustainable Energy Reviews 22 (2013) 621–630

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Pro-environmental attitudes of users and non-users of fuelwood in a rural area of Greece

Garyfallos Arabatzis [a,*], Chrisovalantis Malesios [b]

[a] Department of Forestry and Management of the Environment and Natural Resources, Democritus University of Thrace, Pantazidou 193, 68200 Orestiada, Greece
[b] Department of Agricultural Development, Democritus University of Thrace, Pantazidou 193, 68200 Orestiada, Greece

ARTICLE INFO

Article history:
Received 2 September 2011
Received in revised form
15 February 2013
Accepted 18 February 2013
Available online 17 March 2013

Keywords:
Attitudes
Fuelwood
Multivariate analysis
Consumption
Greece

ABSTRACT

Bioenergy is today considered to be a renewable energy source that can be used, on a short and long-term basis, to replace fossil fuel and reduce the emission of greenhouse gases. Fuelwood is an important source of biomass and plays a significant role in addressing the energy requirements, particularly of the third world.

Concern for the environment has been a dominant social theme over the last decades, and public awareness regarding environmental risks is today greater than ever before. The present study aims to investigate the association between environmental attitudes and the use of biomass energy (bioenergy), especially fuelwood. To achieve this objective, firstly, a measure derived from the survey responses is used to classify individuals according to their evaluation of a number of selected items and secondly, the relation between individual pro-environmental measurements and the use of fuelwood is examined. Thirdly, the introduction of other factors into the analysis, such as income, age, gender and educational level serves to provide further evidence.

Contents

1. Introduction

In the past, fossil fuels in various forms have constituted the main source of energy and have catered for the energy requirements of humans for thousands of years. Around 80% of global energy requirements are covered by fossil fuel [1]. However, successive energy crises from the early 1970s onwards have gradually underlined the importance of using renewable energy sources (wind, hydropower, solar, biomass).

Biomass is one of the most important renewable energy sources that can effectively cater for the energy needs of modern society in both developed and developing countries [2–4,1,5].

* Corresponding author. Tel.: +30 2552041158.
E-mail addresses: garamp@fmenr.duth.gr (G. Arabatzis), malesios@agro.duth.gr (C. Malesios).

1364-0321/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.rser.2013.02.026

A very important source of biomass is wood and especially fuelwood [3].

Biomass can play an important role in increasing the participation of RES in electricity production, according to the EU RES Directive 2001/77 [6]. The applications of biomass-produced energy are constantly improving and can be better understood through various research and development programs, as well as a growing number of practical uses [7].

In 2005, bioenergy accounted for 10% of the total primary energy production worldwide and 78% of the energy globally produced from renewable energy sources [8].

In many developing countries, the proportion of total primary energy production is 80%; however, in many industrialized countries, this figure is less than 5% [9].

Developing countries present a very high dependency on traditional biomass for energy production [10–12]. About 40% of the world's population continues to traditionally use biomass (mainly fuelwood and coal) for cooking [10]. The number of people who depend on the traditional use of biomass is expected to increase from 2.7 billion at present, to 2.8 billion in 2030 [13].

In China, fuelwood plays a significant role in covering the energy requirements of rural households [14,15]. Nevertheless, despite having abundant biomass resources, China has not yet utilised them on a broad basis [16]. In India also, which is a rapidly expanding economy, fuelwod continues to be the main resource used to cover the energy demands of rural households [17].

During the last few years however, fuelwood is also being widely used in countries which are suffering from the economic crisis, such as Greece [18,19]. On the other hand, this great dependency of people worldwide on biomass fuels is one of the main causes of deforestation. Furthermore, there is an increase in the household demand for fuelwood, due to the inefficient way in which it is being used [20].

Bioenergy is considered to be a crucial factor in enhancing the sustainable development of rural areas, through the promotion of crops that are not food-related; at the same time, priority is given to the development of energy crops and to the afforestation of agricultural land [1]. The successive reforms of the CAP since the early 1990s have significantly contributed to the afforestation of agricultural land and, consequently, to an increase in wood production [4].

In this study, we have carried out an empirical analysis in the prefecture of Larissa, to investigate the association of environmental attitudes and the use of biomass energy (bioenergy), especially fuelwood, according to data obtained from 385 households (respondents). The data were gathered using a questionnaire and descriptive statistical analysis was utilized. Furthermore, the relation between pro-environmental behavior – as measured in the current study through a confirmatory factor analysis (CFA) model – and the use of renewable energy sources, such as fuelwood, is investigated.

2. Fuelwood production in Greece

Greece is a mountainous country, since 2/3 of the country consists of mountainous and semi-mountainous areas. According to the census of 1992, forests and other forested areas cover 6513,068 ha, i.e., 49.3% of its total area [21]. The productivity of Greek forests is low, when compared to the average productivity of forests in Europe [22].

As expected, the investments that are made in Greek forestry are also very limited, when compared to the investments made in other productive sectors of Greece. However, the products produced in Greek forests and forested areas, as well as the services they provide, play a significant role for the economy of the country and the life quality of its people [23]. More specifically, the production of fuelwood in recent years has exceeded 70% of the total wood production volume [24,25].

The annual average production of fuelwood in Greece is estimated at 400,000–500,000 t of oil equivalent, which means that the produced energy covers 1.5–2% of the total energy needs of the country [22].

This contribution is not considered to be small or negligible nationally, since it is a subside for imported energy worth millions of Euros; on a regional and local scale, the impact is much greater and supports the overall effort of decentralized growth.

The apparent consumption of woodfuels in all periods of Greek forestry has been covered almost entirely by the domestic production. The imports of woodfuels, particularly up to 1960, were minimal, and limited mainly to the import of coal, especially from the neighbouring Balkan countries. Exports were also minimal [26]. In 1922, the apparent consumption and domestic production amounted to 5.0 million cubic meters, while in 2005 the domestic production amounted to approximately 1.1 million cubic meters, and the apparent consumption to about 1.3 million cubic meters, presenting thus a continuously decreasing trend. In the past few years, a reduction in the amount of produced fuelwood has been observed in Greece [25]. The consumption of fuelwood is covered almost entirely by the domestic production, which cannot increase without a simultaneous reduction in the produced volume of the more valuable industrial wood.

In the past, a large demand for fuelwood existed. However, the said demand gradually decreased in rural areas and its use in urban housing was very limited [27]. More specifically, during the period 1960–1970, a significant reduction in demand for fuelwood was observed, since it was replaced by other modern heating materials (i.e. oil, electricity) [28]. After the oil crisis of 1973 and the rise in liquid fuel pricing, a relative shift in the demand for fuelwood as a means of heating was observed in the rural provinces of Greece. In general, the reduced demand for timber, as a raw material for heating, had resulted in a crisis concerning the disposal of fuelwood and in the effort to exploit it for other uses [28].

In mountainous regions, the demand for fuelwood is rather constant and not income-related, since heating is substantially linked to the citizens' living conditions.

3. Measuring environmental attitudes

Environmental attitudes (EA) are a crucial construct in environmental literature and an exceptionally large number of EA measures have been presented in the relevant literature [29]. EA have a significant influence on public policies. Each community may have different characteristics that should be taken into consideration during the planning and application of public policies, concerning the production and consumption of fuelwood in Greece. Consequently, it is essential to be able to measure the environmental attitudes of a community. Previous studies have shown that environmental responsibility and the concern for energy sources can be directly or indirectly linked with our daily energy-based actions [30].

Certain studies have highlighted the importance of investigating preferences regarding total energy consumption, while others [31–34] have investigated norm-motivated behaviour for switching to green electricity, and [35] the psychological determinants of attitude toward willingness to pay for green electricity.

Another study [36] has shown that a generalised ecologically-minded behaviour is to a large extent determined by peoples' environmental knowledge and environmental values. The above-mentioned studies provide evidence that pro-environmental behaviour is associated with concerns about the environment

and the community, as well as opportunities to conduct pro-environmental activities.

The conservation of the environment has been a major challenge, especially in the last few years. Environmental problems may vary in scale and diversity. Forest protection is one of the basic priorities that exist. Forests serve multiple and interrelated social, economic and environmental functions, often at the same time and place [23].

EA can be defined as 'the collection of beliefs and behavioral intentions a person holds regarding environmentally-related activities or issues' [37]. Many studies have demonstrated that EA seem to predict ecological behavior [36,38].

There are several scales measuring EA in the literature, but no globally-accepted standard measure. In general, the techniques of attitude measurement can be broadly organized into different self-report methods and implicit measurement techniques.

Broadly speaking, there seem to be two main approaches to the dimensionality of EA. One approach sees EA as a uni-dimensional, bipolar construct. According to this traditional approach, EA are seen to range from 'unconcerned about the environment' at the low end to 'concerned about the environment' at the high end [39–41]. Proponents of this approach have measured EA using the New Environmental Paradigm (NEP) scale [42,43].

A second approach views EA as a multidimensional construct related to value-based orientations. The value-based orientations can have either two or three dimensions. In the two-dimensional tradition, EA are classified as rooted in either a concern for all living things (ecocentric concern) or in a concern for humans (anthropocentric concern). These two dimensions of concern are typically measured using Thompson and Barton's [44] scales. The three-dimensional tradition is based on Stern and Dietz's [45] theory of the value basis of environmental concern. In this theory, Schwartz's [46] norm-activation model of altruism is expanded, and a tripartite classification of value orientations towards environmental concern is presented.

To contribute to this difficult issue, an environmental attitude measurement will be presented in the following paragraphs, indicating the variables selected and the total measurement technique applied to data concerning the Greek area of Larissa.

As far as we know, this is a first attempt to associate an overall indicator representing the environmental attitudes of citizens living in a Greek rural area, with the frequency of use of a renewable energy source, such as fuelwood, and then investigate the relevant results. In addition, in the final part of the article, an analysis of potential differences in environmental attitudes according to socio-demographic characteristics, such as gender and educational level, will be presented.

4. Study area and research methodology

The research was carried out in Larissa prefecture (March 2011) and, more specifically, in municipal districts with under 10,000 residents, according to the 2001 census of the National Statistical Service of Greece [47]. Larissa prefecture is located in Central Greece and is mainly a rural area (Map 1).

Larissa prefecture is the top producer of cotton in Greece (21% of the country's total production) and wheat (15% of the total production of Greece). Agriculture accounts for 15.5% of the prefecture's GDP, with the services sector in first place with 65% [48].

For the data collection, an anonymous questionnaire was used. The questionnaire used in the present research mainly included closed-type questions, as well as some open-type questions, e.g., the question on fuelwood consumption and the purchase price of fuelwood, which were addressed to fuelwood users.

Map 1. Prefecture of Larissa.

The research was conducted using a structured questionnaire and the method selected was face-to-face interviews. An interview is the best way of collecting statistical data and is broadly used in sampling research [49]. On the first page of the questionnaire, the main objective of the study was stated, i.e., to obtain information on the use of fuelwood and attitudes towards fuelwood use for household purposes.

The questionnaire was divided into four parts. The first part included questions about the residents' experiences and opinions vis-à-vis different aspects of fuelwood usage. More specifically, the first part was only aimed at users of wood for heating and cooking, and concerned the category of fuelwood use (main, back-up or for pleasure) and the main characteristics of its consumption. The second part involved the whole sample (users and non-users) and included questions on the main heating sources used by the household, the characteristics of the household members and their residence, and any recent changes made in the heating sources used. Another section included more general questions, related to forest policies and environmental issues. The questionnaire examined, amongst other factors, the attitudes of respondents towards environmental problems. Some of these variables were additionally included in the investigation of factors influencing wood consumption.

The last part collected information on the socio-economic profile of the members of the household interviewed, such as their age, educational level and profession. As concerns fuelwood in particular, the questionnaire included two questions, one about whether or not the respondents used fuelwood in the first place, and another question that was addressed to those who gave a positive answer to the first question, and asked them to state their annual fuelwood consumption.

4.1. Sampling—Statistical methodology

The probability sampling technique selected was simple random sampling (SRS) that allows one to design, in a simple manner, valid conclusions about the entire population, based on the sample [50–53].

The target population involved the total number of households in Larissa prefecture (municipal districts with under 10,000 residents). The sampling frame used involved lists of household electricity consumers. This procedure was considered the most appropriate choice, since electricity is used by almost 100% of households in the prefecture. Tables of random digits were subsequently utilized in order to select the households for the sample (full name and address), where personal interviews with one – randomly selected – adult member of the household were conducted. In

cases where the questionnaires were not answered (e.g. respondents were not found or refused to answer), two more attempts were made to obtain their opinion. When this was not possible, we used the same procedure from the beginning to select new sampling units.

The selection process for the respondents (from a household chosen at random) was organized so that the same household member would not always be chosen (i.e. the head of the household, a spouse, etc.) [53–55].

For the sample size selection, the following SRS formula was used:

$$n=\frac{t^2\hat{p}(1-\hat{p})}{e^2}$$

where $\hat{p}=\sum_{i=1}^{n}(p_i)/n$ denotes the estimate of the population proportion that share a certain characteristic regarding one of the (categorical) variables in the survey, and e is the proportion of error we are prepared to accept between the sampling proportion and the unknown proportion of the population (we accept that $e=5\%$).

The questionnaire was initially piloted using a pre-sample of 50 households, in order to estimate the variable with the greatest variance under the pre-defined selected error, while the rest are estimated with a greater accuracy than was initially defined.

According to the pilot survey, the highest proportion value is $p=0.49\approx 0.50$, and the required total sample size n is thus determined by:

$$n=\frac{t^2\hat{p}(1-\hat{p})}{e^2}=\frac{1.96^2\cdot 0.5\cdot(1-0.5)}{0.05^2}=384.16$$

The present analysis is therefore based on a survey of 385 households (respondents) as selected in our sample.[1]

The statistical and econometric analyses were carried out with the help of the package SPSS 15.0 [57]. Apart from the descriptive analysis of individual items from the questionnaire and statistical tests, such as one-way analysis of variance, a CFA analysis of the questionnaire's qualitative variables was carried out with the use of LISREL 8.8 software [58], in an attempt to estimate individual environmental attitudes.

5. Analysis

5.1. Descriptive analysis of the data

Of the respondents, 64.7% (249 respondents) are users (consumers) of fuelwood. The vast majority of wood users in the prefecture of Larissa declare that they easily find the fuelwood they require on the local market (234 or 96.7%).

As concerns socio-economic information, 59.7% of the respondents were males, while most of the respondents were aged between 51 and 60 years old (123 or 31.9%) (Table 1). The interviewees had to choose the annual income bracket to which they belonged (up to €10,000; from €10,001 to €20,000; from €20,001 to €30,000; and over €30,000). The professions of the household members were the following: farmer, employee, housewife, freelancer and unemployed. Almost half were of a middle educational level (54.3%). The appendix provides a summary of all the socio-economic variables used, along with their definition, as well as other variables used in the relevant analysis.

Table 1
Socio-demographic characteristics of respondents.

	Frequency	Percentage
Gender		
Male	155	40.3
Female	230	59.7
Total	385	100.0
Age of household member		
≤ 30	59	15.3
31–40	101	26.2
41–50	102	26.5
51–60	123	31.9
Total	385	100.0
Level of education		
Lower	109	28.3
Middle	209	54.3
Upper	67	17.4
Total	385	100.0
Household income		
€ ≤ 10,000	179	46.5
€10,001–€20,000	175	45.5
€20,001–€30,000	31	8.1
Total	385	100.0
Profession of household member		
Farmer	77	20.0
Housewife	154	40.0
Employee	93	24.2
Freelancer	39	10.1
Student	14	3.6
Unemployed	8	2.1
Total	385	100.0

The average annual quantity of fuelwood used came to 6.78 t[2] (median consumption: 8 t/year), for those consuming wood. The average consumption amounted to 4.87 t/year for households using wood as a source of heating (for households using wood for both heating and cooking, it was 8.86 t/year). As concerns the reasons for using wood for household purposes, those who use fuelwood, said that they use it mainly because it is less expensive than oil ('agree' or 'fully agree', 71.5%). Other reasons mentioned, were that it is less expensive than other energy sources in general ('agree' or 'fully agree', 58.7%). The least common reasons for using fuelwood were the ease of obtaining fuelwood ('agree' or 'fully agree', 12.8%), and environmental reasons (16.1%).

The average price per ton for the sample consuming wood came to €110.68 (min=€108, max=€112), representing an average annual budget of €750.41 per household. Between the various professions and socio-professional categories (of the head of the household), fuelwood use varied little on initial analysis. It should be noted, however, that wood was widely used by housewives and employees and least used by students.

Additionally, it was observed that central heating with the use of an oil boiler was the most widely-used source of heating (190 respondents or 49.4%), followed by central heating with the use of wood stoves (165 or 42.9%) or a fireplace (62 or 16.1%).

Among the households in the sample, 64.7% use fuelwood as a source of heating (and for cooking), followed by electricity (54%), and to a lesser extent, fuel oil (49.4%) and liquid gas (29.9%).

[1] By using the continuous variable with the greatest variance in our study (size of residence in m^2) with a sample average of 75.45 and a corresponding standard deviation of 15.037, and by using the formula for sample size selection for continuous variables given by $n=t^2s^2/e^2$, we are led to a minimum sample size of 231, which is well below the chosen sample size based on the categorical variables in our study. [56].

[2] However, the actual fuelwood consumption (i.e. consumption calculated by considering both users and non-users) varies from 0 to 11 t (average consumption was 4.34 t/year, s.d.=4.078).

5.2. A CFA model to examine the association between environmental attitudes and fuelwood use

CFA is applied when attempting to explicitly test an already stated hypothesis; it provides the opportunity to test hypotheses about a specific factor structure imposed a priori. CFA is a technique, which may be used for the measurement of environmental attitudes [59–61] or environmental concerns [62,63].

In order to proceed with the investigation of measurable dimensions of environmental attitudes in more detail, and to capture spatial variations of crucial features of the environmental attitudes within Greece, an environmental attitude score index was created for the fuelwood users and non-users included in our study, by utilizing a second-order confirmatory factor analysis model.

In general, a typical CFA model can be expressed as

$$x = \boldsymbol{\Lambda}\boldsymbol{\xi} + \boldsymbol{\delta}$$

where $\mathbf{x}$ denotes the $(p \times 1)$ vector of the observed variables, ξ are the m (unknown) factors, $\boldsymbol{\Lambda}$ is the $(\mathrm{p} \times \mathrm{m})$ matrix of the unknown factor loadings to be estimated, connecting ξ to the the x_{ij}s, and $\boldsymbol{\delta}$ is the $(p \times 1)$ vector of measurement errors (i.e. the part of $\mathbf{x}$ that cannot be accounted for by the underlying factors ξ). It is further assumed that the error terms $\boldsymbol{\delta}$ and the common factors ξ have a zero mean and that the common and unique factors are uncorrelated.

Then, the variance–covariance matrix of the data denoted by $\boldsymbol{\Sigma}$ is given by:

$$\boldsymbol{\Sigma} = \boldsymbol{\Lambda}\boldsymbol{\Phi}\boldsymbol{\Lambda}^t + \boldsymbol{\Theta},$$

where $\boldsymbol{\Phi}$ denotes the variance–covariance matrix of ξ, and $\boldsymbol{\Theta}$ denotes the variance–covariance matrix of the measurement errors. The aim is to estimate the unknown elements of $\boldsymbol{\Lambda}$, $\boldsymbol{\Phi}$ and $\boldsymbol{\Theta}$.

Such models are usually fit by maximum likelihood, however for non-normally distributed data, for instance data measured on an ordinal scale, the preferred method is the method of weighted least squares.

5.3. Variables included in the measurement and confirmatory factor analysis

The dimensionality of environmental attitudes remains an unresolved theoretical and empirical issue. The present research addressed this issue by constructing and testing a model in order to estimate individual environmental attitudes for the prefecture of Larissa. To this end, CFA was used, which permits the testing of hypotheses with a specific factor structure.

In particular, nine observed variables were selected – all of them measured on an ordinal scale – which were subsequently included in three factors. These variables relate to modern environmental problems, the benefits provided by forests and the measures for the establishment of new forests.

More specifically, until fairly recently, the main priority of forest policies on an international level was the exploitation and valorization of the forests' productive resources, and the implementation of effective forest management practices. Nevertheless, various negative developments, such as the extensive deforestation and its grave impact on the environment (destruction of biodiversity, climate change, protection of the soil and water resources), have contributed towards a gradual shift in the emphasis of forest policies, towards promoting the multi-functional role of forests (social, productive, cultural, environmental) [23,53].

In recent decades, the continuous changes taking place in rural areas have also resulted in transforming the role played by forestry. In the past, forestry paid attention to those functions of the forest that were related to primary production (mainly wood and resin production), in order to strengthen the economy of rural areas, provide employment and an income for the local population, and ensure the provision of raw materials. At present, forestry mainly focuses on maintaining the ecological balance of forests and forested areas, and on enhancing those environmental benefits that upgrade the quality of life of the ever-increasing urban population [23,53].

Forest policy is considered by many to be a major part of the European Union rural development policy [64]. The importance of forestry, and its contribution to the diversification and integrated development of the countryside is underlined both on a European Union and on a member-state level, through actions related to the protection and growth of existing forests, and also through the establishment of forest plantations in forest and agricultural areas. In addition, special attention should also be paid to the improved management of existing forests, so that they may contribute to conserving the financial viability, social attractiveness and ecological integrity of rural areas [23,53]. Furthermore, the overall objective of the EU action plan for forests (2007–2011) is to support and expand the sustainable management of forests and their multi-functional role.

The specific items comprising the questionnaire were selected in order to assess three primary environmental-attitude factors. These three factors were:

(a) The first factor [ENV_KNWL] measured *knowledge of environmental problems* and consisted of four variables measuring the participants' awareness of four major environmental problems, such as: 'Destruction of tropical forests', 'Greenhouse effect', 'Carbon dioxide emissions', and 'Drought'. Components of recognition of environmental problems are often included in similar measurement models of environmental attitudes [59].
(b) The second factor [BNF_FRST] dealt with *possible benefits from forests for the environment*. For the measurement of this factor, three variables were included. The selected questions concerning the priority that should be given in future to each potential benefit from the forests found near the prefecture of Larissa included: 'Protection of the environment', 'Creation of an attractive and beautiful landscape' and 'Protection of air, soil and water'.
(c) A final factor [EST_FRST] created was *measures for the establishment of new forests*, indicating the environment-friendly solutions proposed by the respondents towards the establishment of new forests in the area, or the re-creation of old deforested forests. Two variables were included, namely: 'Marginal agricultural land could be planted with forest trees' and 'Deforested mountain land could be afforested'. Attitudes towards environmental/ecological commitments, such as the conservation of the natural environment, are often included in items aiming to 'assess' environmental behaviour [60].

Table 2 presents the observed items used in the CFA, as well as the latent factors used for the establishment of the measurement index of pro-environmental attitudes.

5.4. Results of the CFA

In order to confirm the suitability of implementing CFA on the specific data and items selected, the Keiser–Meyer–Olkin (KMO) measure of model adequacy was used, which gave the acceptable value of 0.56. The estimation of the CFA model was performed with the LISREL 8.80 software [48]. The CFA indicated that the second-order factor model tested, was a good fit to the nine observed variables. More specifically, the three first-order factors associated with the manifest variables are in turn associated with a single second-order factor, the 'PRO-ENV_ATTD'.

Table 2
Variables and latent factors included in the CFA model.

Factor	Question
Environmental knowledge [ENV_KNWL]	The major global environmental problems are: Carbon dioxide emissions (CDE)
	The major global environmental problems are: Greenhouse effect (GREEN)
	The major global environmental problems are: Destruction of tropical forests (DTF)
	The major global environmental problems are: Drought (DR)
Possible benefits from forests for the environment [BNF_FRST]	Priority that should be given in future to each of the potential benefits from forests found near you: Protection of the environment (ENV_PRT)
	Priority that should be given in future to each of the potential benefits from forests found near you: Create attractive and beautiful landscape (CRT_ATTR_LND)
	Priority that should be given in future to each of the potential benefits from forests found near you: Protection of air, soil and water (AGW_PRT)
Measures for the establishment of new forests[EST_FRST]	Measures for the establishment of new forests in your area: Marginal agricultural land could be planted with forest trees (PFT)
	Measures for the establishment of new forests in your area: Deforested mountain land could be afforested (DLA)

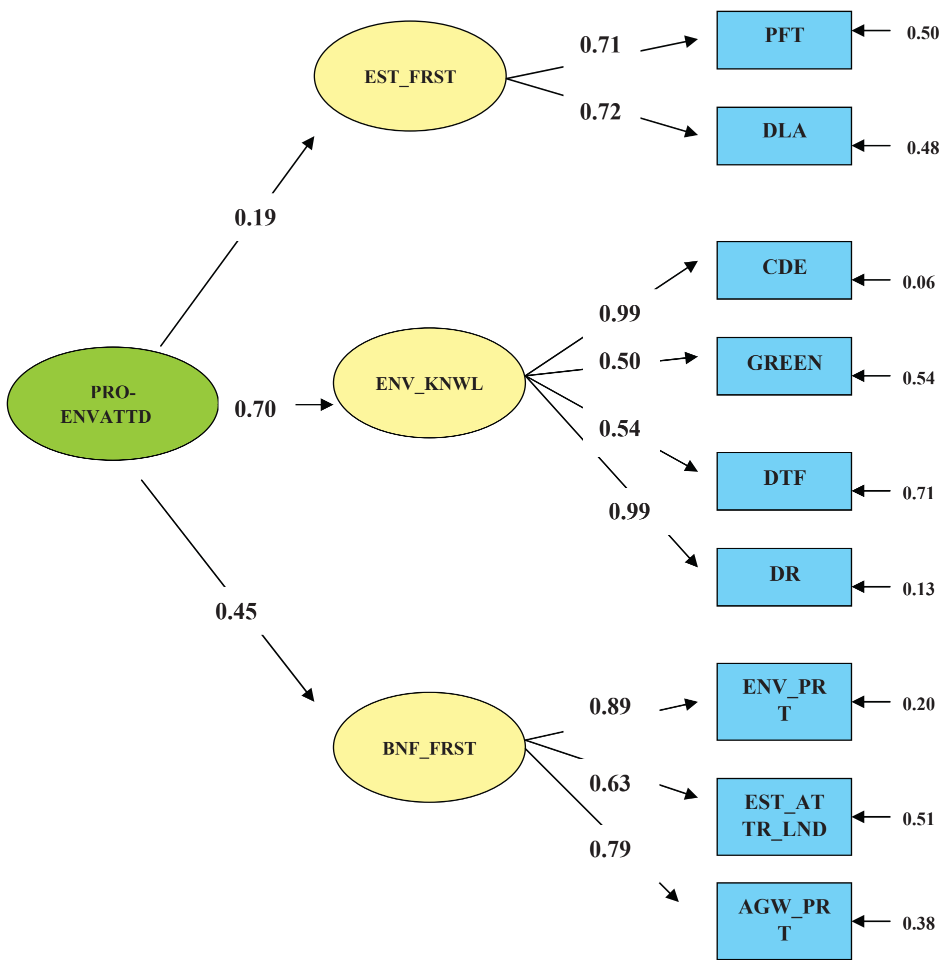

Fig. 1. Path diagram of the second-order factor model.

The estimated CFA model is displayed via the path diagram of Fig. 1. We chose to obtain the model estimates by implementing the weighted least squares estimation methodology, suitable for the analysis of ordinal data via CFA. Most factor loadings (which essentially represent correlations between observed variables and first-order factors and between first-order factors and 'pro-environmental attitude' factor) are significant at a 5% significance level. Accordingly, all three first-order factors are related to the second-order factor, while not all factors are equally related to the 'pro-environmental' factor, as one observes from the path diagram.

In order to test the validity of the proposed model, various fit statistics were used [65], available through the LISREL software. As presented in Table 3, almost all indicators for testing a 'good' model fit fall within the accepted boundaries.

It is not uncommon to estimate individual factor scores [66] in order to utilize them for subsequent statistical analysis. For instance, predicted factor scores may be used as variables in ANOVA and OLS regression (as dependent or explanatory variables) (e.g. [67]) or as input data for cluster [68] and discriminant analysis [69]).

Factor score indeterminacy can be significantly reduced, if observed variables exceed strong relationships with the latent factors. The CFA model presented in this study fulfils the requirement of significant associations between observed and latent

Table 3
Model fit statistics.

Goodness of fit indices	Index value for the second-order factor model	Accepted boundaries for close fit
RMSEA	0.098	0.00–0.06
GFI	0.98	>0.90
AGFI	0.96	>0.90
NNFI	0.99	>0.90
NFI	0.99	>0.90
CFI	0.99	>0.90

Table 4
Pro-environmental scores and use of fuelwood.

Fuelwood use	Average pro-EA score	Std. error	95% confidence interval of the difference		*p*-value
			Lower bound	Upper bound	
Users (Consumers)	2.93	0.016	−0.05	0.056	0.91
non-users (non consumers)	2.94	0.2			

Table 5
Pro-environmental scores and gender.

Gender	Average pro-EA score	Std. error	95% confidence interval of the difference		*p*-value
			Lower bound	Upper bound	
Male	2.927	0.023	−0.07	0.033	0.483
Female	2.946	0.015			

variables (with only a few exceptions), urging us to carry on with the estimation of factor scores and their use for subsequent analysis. We use LISREL to derive factor scores [70] of the second-order CFA model, containing data on the nine observed variables that are used as indicators of the three first-order latent variables, that in turn are used as indicators of the 'pro-environmental attitudes' factor. Once individual score estimates for the sample are obtained, we first test for differences between users and non-users of fuelwood. The results of the independent-samples t-test showed that there are no statistically significant differences regarding the 'pro-environmental' attitudes of users and non-users (Table 4).

5.5. Differences in gender, age and educational level with regard to the use of fuelwood

In the current section, an investigation into the possible influence of basic social characteristics on the individual measurement of pro-environmental attitudes is attempted. For this purpose, the independent samples t-test for equality of means and one-way analysis of variance (ANOVA) are utilized, using factor score estimates as the dependent variable and variables of social characteristics as explanatory variables.

Differences related to gender were first explored. The results showed that the average 'pro-environmental' score is not significantly statistically different (p-value$=0.483>0.05$) between male individuals (2.927) and females (2.946) (Table 5), i.e. in the current study there were no significant gender differences found in pro-environmental attitudes, despite the fact that other relevant studies have reported such differences [71,72].

In addition, through the one-way analysis of variance, significant differences between the average scores of respondents with different educational levels were observed. More specifically, the one-way analysis of variance F-test rejected the null hypothesis of no differences in the average pro-environmental scores between people with varying educational levels ($F=53.96$, p-value<0.001). As indicated in Table 6, the upper and lower levels of education are statistically significantly related with higher levels of pro-environmental attitudes. On the other hand, respondents with a mid-level education presented the lowest pro-environmental scores.

Finally, regarding the age of the respondents, there were also statistically significant differences between the average scores of the respondents belonging to the various age categories. More specifically, Table 7 clearly shows that the average scores for the age category '41–50' differ statistically significantly when compared to the scores of the younger (≤ 30) and older respondents (51–60 y.o.). The highest stocks of pro-environmental attitudes are attributed to the younger and older respondents (average score$=$2.962 and 3.013, respectively).

To get further insight into the associations between the various socio-demographic factors and the use of fuelwood, based on the pro-environmental scores, we then used two-way analysis of variance models. First of all, a two-way ANOVA model, with the factor scores as the dependent variable and the variables 'use of fuelwood' and 'gender' as fixed-effects factors, was fitted to the data. The results of the analysis are shown in Tables 8 and 9.

The results reveal that there are significant differences between fuelwood users and non-fuelwood users and their environmental attitudes, with regard to gender. More specifically, the results of the two-way ANOVA show that when considering simultaneously the effects of gender, the use of fuelwood and their interaction,

Table 6
Pro-environmental scores for the various levels of education (Scheffé's multiple comparison t-test).

Level of education	N	Subset for alpha$=$.05	
		1	2
Middle	209	2.830	
Lower	109		3.081
Upper	67		3.046

Table 7
Pro-environmental scores for the various age groups (Scheffé's multiple comparison t-test).

Age	*N*	Subset for alpha$=$.05	
		1	2
41–50	102	2.836	
31–40	101	2.936	2.936
51–60	123		3.013
≤ 30	59		2.962

Table 8
Pro-environmental scores for the various levels of fuelwood use and gender.

Fuelwood use	Gender	Mean	Std. Deviation	N
Users (Consumers)	Male	2.839	0.242	111
	Female	3.016	0.254	138
Non-users (non consumers)	Male	3.149	0.263	44
	Female	2.841	0.143	92
Total		2.938	0.255	385

Table 9
Results of two-way ANOVA for mean Pro-environmental scores with reference to fuelwood use and gender.

Source of variation	*F*-value	*p*-Value
Gender	6.822	0.009
Fuelwood use	6.585	0.011
Interaction (gender × use)	89.228	< 0.001

Dependent variable:pro-environmental scores $R^2=0.994$ (adjusted $R^2=0.994$).

Table 10
Pro-environmental scores for the various levels of fuelwood use and educational level.

Fuel wood use	Level of Education	Mean	Std. deviation	*N*
Users (consumers)	Lower	3.051	0.254	86
	Middle	2.787	0.197	117
	Upper	3.105	0.221	46
Non-users (non consumers)	Lower	3.194	0.295	23
	Middle	2.883	0.173	92
	Upper	2.916	0.246	21
Total		2.938	0.255	385

Table 11
Results of two-way ANOVA for mean pro-environmental scores with reference to fuelwood use and educational level.

Source of variation	*F*-value	*p*-value
Educational level	51.581	< 0.001
Fuelwood use	0.339	0.56
Interaction (educational level × use)	11.33	< 0.001

Dependent variable: pro-environmental scores $R^2=0.995$ (adjusted $R^2=0.995$).

Table 12
Pro-environmental Scores for the various levels of fuelwood use and age.

Fuel wood use	Age	Mean	Std. deviation	N
Users (Consumers)	≤ 30	3.129	0.240	23
	31–40	2.915	0.236	70
	41–50	2.813	0.092	63
	51–60	2.991	0.321	93
Non-users (non consumers)	≤ 30	2.857	0.207	36
	31–40	2.985	0.192	31
	41–50	2.875	0.195	39
	51–60	3.080	0.296	30
Total		2.938	0.255	385

we observe a significant difference between male and female respondents ($F=6.822$, p-value$=0.009<0.05$), and users and non-users ($F=6.585$, p-value$=0.011<0.05$). The results also indicate that there is a significant difference between male and female respondents with regard to the household use of fuelwood for various purposes ($F=89.228$, p-value<0.001). Male non-users have a better attitude towards their environment (average score=3.149), followed by the female users of fuelwood (average score=3.016).

Next, we performed a comparison of environmental attitudes of users and non-users of fuelwood with respect to their educational level. Tables 10 and 11 indicate that there is a significant difference in pro-environmental scores between users and non-users of different educational levels ($F=11.33$, p-value<0.001). Non-users of a lower educational level (average score=3.194), followed by users of an upper educational level (average score=

Table 13
Results of two-way ANOVA for mean Pro-environmental Scores with reference to fuelwood use and age.

Source of variation	*F*-value	*p*-Value
Age	10.758	< 0.001
Fuelwood use	0.222	0.638
Interaction (age × use)	8.083	< 0.001

Dependent variable: pro-environmental scores $R^2=0.994$ (adjusted $R^2=0.993$).

3.105) and users of a lower educational level (average score= 3.051) exceed the highest levels of pro-environmental attitudes.

Finally, the statistical results from Tables 12 and 13 indicate that there is no significant difference in the environmental attitudes of fuelwood users and non-fuelwood users. The results of the interaction effects however, between the age of the respondents and the use of fuelwood are significant, at a 1% level of significance ($F=8.083$, p-value<0.001). Younger users of fuelwood (≤ 30 y.o.) and older non-users (51 to 60 y.o.) are those with the highest levels of pro-environmental attitudes (average scores: 3.129 and 3.08 respectively).

6. Conclusions

The nature and dimensions of the current ecological crisis render essential great changes in the attitude and, even more importantly, the behaviour of citizens. Presently, the deadline for achieving the objectives of the environmental policy is particularly demanding. More than ever before, interventions are required at all levels which need to be direct and particularly effective, given the intense pressure exercised by the dynamic nature of various environmental concerns.

As regards forests, their basic use involves the production of raw materials, the application of energy-saving measures and their use in relation to socio-political requirements. Even today, a large percentage of the population in the third world is wholly dependent on wood, both for heating and for cooking food.

The objective of the current study was twofold: on the one hand to highlight the characteristics of the consumption and use of fuelwood in a rural area, and on the other hand to attempt an investigation of the possible connection between the use of fuelwood as a renewable source of energy and pro-environmental attitudes.

The observation that arises from the results of the present research indicates that the respondents generally show a positive attitude towards environmental issues. It is also indicated that socio-demographic characteristics, such as age and educational level, in relation to behaviour towards fuelwood use, can adequately explain the differences in pro-environmental attitudes, as measured by our CFA model.

Amongst other findings, it was observed that there were differences in terms of the respondents' environmental attitudes according to their socio-demographic characteristics, such as gender, age and educational level, when accounting for fuelwood use behaviour also. A two-way analysis of variance revealed significant interaction effects between individual socio-demographic characteristics and behaviour towards fuelwood use; for example, within the users group, the lower the age of the respondent (≤ 30 y.o.), the higher his/her pro-environmental attitude, and conversely, within the non-users group, the higher the age of the respondent 51–60 y.o.), the higher their pro-environmental attitude. We have also observed that female users of fuelwood show a more positive environmental attitude when compared to male users, and conversely, male non-users present a more positive

environmental attitude when compared to female non-users. Non-users of fuelwood of a lower educational level have a more pro-environmental attitude than more educated non-users, however, when we consider users of fuelwood, of both a lower and upper educational level, we observe that they are more environmentally positive than the respondents with a mid-level education.

In general, it was found that there is a pro-environmental attitude among the citizens. They seem to be concerned about issues of environmental protection and the importance of sustainable development. Further awareness-raising amongst the citizens on environmental issues is a prerequisite for the successful application of policies and implementation programs aiming at environmental protection and sustainable development.

In conclusion, the contribution of this study is primarily focused on investigating the crucial elements of fuelwood use and fuelwood consumption in a rural area of Greece; it also examines the possible effects and connection of pro-environmental attitudes – as measured with the use of several pro-environmental items – with the domestic use of fuelwood. Although we consider the measurements conducted in this study to be satisfactory vis-à-vis its final objective, further research and improvements can be introduced in order to further ameliorate the measurement techniques, in an effort to generalize the findings of the current study, which was conducted only through a particular dataset.

Table A1
Variables' operationalization.

Individual-level demographic variables	Values
Age	Age cohorts: ≤30 years old (1), 31–40 (2), 41–50 (3), 51–60 (4), >60 years old (5)
Gender	Male (1), female (2)
Educational level	Lower (1), middle (2), upper (3)
Household income	1: ≤€10,000 2: €10,001-€20,000 3: €20,001-€30,000 4: >€30,000
Profession	1: Farmer, 2: Housewife, 3: Employee, 4: Freelancer,5: Unemployed
Environmental information variables	**Values**
The major global environmental problems are	1: Carbon dioxide emissions 2: Greenhouse 3: Destruction of tropical forests 4: Drought
Priority that should be given in future to each of the potential benefits from forests found near you:	1: Protection of the environment 2: Create attractive and beautiful landscape 3: Protection of air, soil and water
Measures for the establishment of new forests in your area:	1: Marginal agricultural land could be planted with forest trees 2: Deforested mountain land could be afforested
Fuelwood information variables	**Values**
Source of heating	1: Fuelwood 2: Oil 3: Electricity 4: Liquid gas 5: Natural gas
Reasons for fuelwood usage	1: Less expensive than oil, 2: Less expensive than other energy sources 3: Ease in obtaining fuelwood 4: Environmental reasons 5: Recreational reasons 6: Aesthetic reasons
Purchase price of fuelwood	Continuous
Fuelwood consumption (yearly)	Continuous
Fuelwood use in household for various purposes	1: Yes 2: No

Appendix A

See Table A1.

References

[1] Vamvuka D. Biomass, bioenergy and environment. Tziola Thessaloniki 2009 [in Greek].
[2] Uddin SK, Taplin R, Yu X. Energy, environment and development in Butan. Renewable and Sustainable Energy Reviews 2007;11(9):2083–103.
[3] Mirza U, Ahmad N, Majeed T. An overview of biomass energy utilization in Pakistan. Renewable and Sustainable Energy Reviews 2009;12(7):1988–96.
[4] Koutroumanidis T, Ioannou K, Arabatzis G. Predicting fuelwood prices in Greece with the use of ARIMA models, artificial neural networks and a hybrid ARIMA–ANN model. Energy Policy 2009;37(9):3627–34.
[5] Cai J, Jiang Z. Energy consumption patterns by local residents in four nature reserves in the subtropical broadleaved forest zone of China. Renewable and Sustainable Energy Reviews 2010 2010;14(2):828–34.
[6] Boukis I, Vassilakos N, Kontopoulos G, Karellas S. Policy plan for the use of biomass and biofuels in Greece: Part I: Available biomass and methodology. Renewable and Sustainable Energy Reviews 2009;13(5):971–85.
[7] Demirbas MF, Balat M, Balat H. Potential contribution of biomass to the sustainable energy development. Energy Conversion and Management 2010;50(7):1746–60.
[8] IEA. Key world energy statistics; 2007. p. 1–82.
[9] Keam S, McCormick N. Implementing sustainable bioenergy production: a compilation of tools and approaches. Gland, Switzerland: IUCN; 2008.
[10] Maes W, Verbist B. Increasing the sustainability of household cooking in developing countries: policy implications. Renewable and Sustainable Energy Reviews 2012;16(6):4204–21.
[11] Oseni M. Improving households' access to electricity and energy consumption pattern in Nigeria: renewable energy alternative. Renewable and Sustainable Energy Reviews 2012;16(6):3967–74.
[12] Gurung A, Oh S-E. Conversion of traditional biomass into modern bioenergy systems: a review in context to improve the energy situation in Nepal. Renewable Energy 2013;50:206–13.
[13] Kaygusuz K. Energy for sustainable development: a case of developing countries. Renewable and Sustainable Energy Reviews 2012;16(2):1116–26.
[14] Jingchao Z, Kotani K. The determinants of household energy demand in rural Beijing: can environmentally friendly technologies be effective? Energy Economics 2012;34(2):381–8.
[15] Wang C, Yang Y, Zhang Y. Rural household livelihood change, fuelwood substitution, and hilly ecosystem restoration: evidence from China. Renewable and Sustainable Energy Reviews 2012;16(5):2475–82.
[16] Chen L, Li X, Wen W, Jia J, Li G, Deng F. The status, predicament and countermeasures of biomass secondary energy production in China. Renewable and Sustainable Energy Reviews 2012;16(8):6212–9.
[17] Khuma YSC, Pandey R, Rao KS. Micro-watershed level population based fuelwood consumption dynamics: Implications of seasonal vs. annual models for sustainable energy resource planning. Renewable and Sustainable Energy Reviews 2012;16(8):6142–8.
[18] Arabatzis G, Malesios C. An econometric analysis of residential consumption of fuelwood in a mountainous prefecture of Northern Greece. Energy Policy 2011;39(12):8088–97.
[19] Arabatzis G, Kitikidou K, Tampakis S, Soutsas K. The fuelwood consumption in a rural area of Greece. Renewable and Sustainable Energy Reviews 2012;16(9):6489–96.
[20] Jan I. What makes people adopt improved cookstoves? Empirical evidence from rural Northwest Pakistan Renewable and Sustainable Energy Reviews 2012;16(5):3200–5.
[21] Ministry of Agriculture. Results of first national forest census. Athens; 1992 [in Greek].
[22] Ministry of Agriculture. Criteria and indicators for the sustainable forest management in Greece. Athens; 2000 [in Greek].
[23] Arabatzis G. Development of Greek forestry in the framework of the European Union policies. Journal of Environmental Protection and Ecology 2010;11(2):682–92.
[24] Ministry of Rural Development and Food. Activities report of the Forest Services of the Ministry of Rural Development and Foods for the year 2006. Athens; 2008 [in Greek].
[25] Ministry of Rural Development and Food. Activities report of the Forest Services of the Ministry of Rural Development and Foods for the year 2007. Athens; 2009 [in Greek].
[26] Stamou N. Marketing of forest products. Thessaloniki 2006 in Greek.
[27] Blioumis V, Christodoulou Th. The fuel wood consumption from 1963 to 1980 especially in Greece. Thessaloniki: Scientific Annals of the School of Forestry and Natural Environment, Aristotelian University of Thessaloniki; 1982 [in Greek].
[28] Soutsas K. Forest economy. Karditsa 2000 [in Greek].

[29] Dunlap RE, Jones RE. Environmental concern: Conceptual and measurement issues. In: Dunlap RE, Michelson W, editors. Hanbook of environmental sociology. Westport, CT: Greenwood Press; 2002.

[30] Held M. Social impacts of energy conservation. Journal of Economic Psychology 1983;3:379–94.

[31] Bin S, Dowlatabadi H. Consumer lifestyle approach to US energy use and the related CO_2 emissions. Energy Policy 2005;33:197–208.

[32] Haas R, Auer H, Biermayr P. The impact of consumer behaviour on residential energy demand for space heating. Energy and Buildings 1998;27:195–205.

[33] Ek K (2005). The economics of renewable energy support. Doctoral thesis. Division of Social Sciences, Economics Unit, Luleå University of Technology; 2005.

[34] Ek K, Soderholm P. Norms and economic motivation in the Swedish green electricity market. Ecological Economics 2008;68(1-2):169–82.

[35] Hansla A, Gamble A, Juliusson A, Garling T. Psychological determinants of attitude towards and willingness to pay for green electricity. Energy Policy 2008;36:768–74.

[36] Kaiser FG, Wolfing S, Fuhrer U. Environmental attitude and ecological behavior. Journal of Environmental Psychology 1999;19:1–19.

[37] Schultz PW, Shriver C, Tabanico J, Khazian A. Implicit connections with nature. Journal of Environmental Psychology 2004;24:31–42.

[38] Hines JM, Hungerford HR, Tomera AN. Analysis and synthesis of research on responsible environmental behavior: a meta-analysis. Journal of Environmental Education 1987;18(2):1–8.

[39] Pierce JC, Lovrich NP. Belief systems concerning the environment: The general public, attentive publics, and state legislators. Political Behavior 1980;2:259–86.

[40] Poortinga W, Steg L, Vlek C. Environmental risk concern and preferences for energy-saving measures. Environment and Behavior 2002;34:455–78.

[41] Schultz PW. Empathizing with nature: The effects of perspective taking on concern for environmental issues. Journal of Social Issues 2000;56(3):391–406.

[42] Dunlap RE, Van Liere KD. The new environmental paradigm. Journal of Environmental Education 1978;9:10–9.

[43] Dunlap RE, Van Liere KD, Mertig A, Jones R. Measuring endorsement of the New Ecological Paradigm: a revised NEP scale. Journal of Social Issues 2000;56:425–42.

[44] Thompson SCG, Barton MA. Ecocentric and anthropocentric attitudes toward the environment. Journal of Environmental Psychology 1994;14:149–57.

[45] Stern PC, Dietz T. The value basis of environmental concern. Journal of Social Issues 1994;50:65–84.

[46] Schwartz SH. Normative influences on altruism. In: Berkowitz L, editor. Advances in experimental social psychology, 10. New York: Academic; 1977. p. 221–79.

[47] NSSG. Results of population census. Athens; 2003 [in Greek].

[48] All Media. The Economic and social profile of the 52 prefectures and 13 regions. Athens; 2008 [in Greek].

[49] Kiochos P. Statistics. Athens: Interbooks Publications; 1993 [in Greek].

[50] Matis K. Forest sampling. Assets exploitation and management company. Xanthi: Democritus University of Thrace; 2001 [in Greek].

[51] Filias V, Pappas P, Antonopoulou M, Zarnari O, Magganara , Meimaris M, et al. Introduction to the methodology and techniques of social research. Athens: Gutenberg Social Library; 1996 [in Greek].

[52] Damianou C. Sampling methodology: Techniques and applications. Athens: Aithra Publications; 1999 [in Greek].

[53] Arabatzis G, Tsantopoulos G, Tampakis S, Soutsas K. Integrated rural development and the multifunctional role of forests: a theoretical and empirical study. Review of Economic Sciences 2006;10:19–38.

[54] Arabatzis G, Kyriazopoulos A. Contribution of rangelands in quality of life: the case of Viotia prefecture, Greece. Journal of Environmental Protection and Ecology 2010;11(2):733–44.

[55] Malesios CH, Arabatzis G. Small hydropower stations in Greece: the local people's attitudes in a mountainous prefecture. Renewable and Sustainable Energy Reviews 2010;14(9):2492–510.

[56] Cochran WG. Sampling techniques. 3rd edition. New York: John Wiley & Sons; 1977.

[57] SPSS Inc. SPSS Base 10.0 for Windows user's guide. SPSS Inc., Chicago IL; 1999.

[58] Jöreskog KG, Sörbom D. LISREL 8 user's reference guide. Lincolnwood, IL: Scientific Software International; 1999.

[59] Grob A. A structural model of environmental attitudes and behavior. Journal of Environmental Psychology 1995;15:209–20.

[60] Milfont TL, Duckitt J. The structure of environmental attitudes: A first- and second order confirmatory factor analysis. Journal of Environmental Psychology 2004;24:289–303.

[61] Milfont TL, Duckitt J. Preservation and utilization: Understanding the structure of environmental attitudes. Medio Ambiente y Comportamiento Humano 2006;7(1):29–50.

[62] Roberts JA, Bacon DR. Exploring the subtle relationships between environmental concern and ecologically conscious consumer behavior. Journal of Business Research 1997;40:79–89.

[63] Bamberg S. How does concern influence specific environmentally related behaviors? A new answer to an old question Journal of Environmental Psychology 2003;23:21–32.

[64] Kennedy J, Thomas J, Glueck P. Evolving forestry and rural development beliefs at midpoint and close of the 20th century. Forest Policy and Economics 2001;3(1-2):81–95.

[65] Marsh HW, Balla J. Goodness of fit in confirmatory factor analysis: the effects of sample size and model parsimony. Quality and Quantity 1994;28:185–217.

[66] Bartholomew D, Knott M. Latent variable models and factor analysis. London: Arnold; 1999.

[67] Urban GL, Hauser JR. Design and marketing of new products. Englewood Cliffs, NJ: Prentice-Hall, Inc;; 1980.

[68] Funkhouser GRA. Note on the reliability of certain clustering algorithms. Journal of Marketing Research 1983;20:99–102.

[69] Horton RL. Some relationships between personality and consumer decision making. Journal of Marketing Research 1979;16:233–46.

[70] Mels G. The student edition of LISREL 8.7 for Windows: getting started guide. Lincolnwood, IL: Scientific Software International, Inc; 2004.

[71] McMillan M, Hoban TJ, Clifford WB, Brant MR. Social and demographic influences on environmental attitudes. Southern Rural Sociology 1997;13(1):89–107.

[72] Shobeiri SM, Omidvar B, Prahallada NN. Influence of gender and type of school on environmental attitude of teachers in Iran and India. International Journal of Environmental Science and Technology 2006;3(4):351–7.